



# Isotopes Project



LAWRENCE BERKELEY NATIONAL LABORATORY

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Nuclear Structure and Decay Data Evaluation and  
Dissemination Activities During Fiscal Year 2005

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Report prepared for the USNDP Annual Meeting, November 9-11, 2005 at Brookhaven  
National Laboratory.



# Isotopes Project



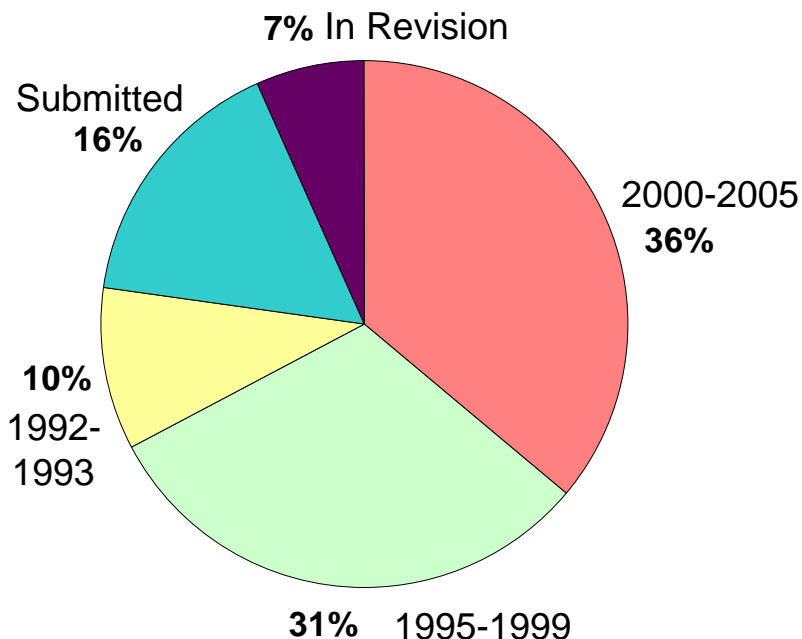
*C. Baglin, S. Basunia, E. Browne, R. Firestone, S.-C. Wu (guest)*

## Mass Chain Responsibility (~473 nuclides):

A=21-30, 59, 81, 83, 90-93, 166-171, 180-193 (ex. 188, 190), 210-217.

## Evaluation Status:

Literature Cutoff Year - LBNL Chains



## FY05 Levels of Effort: (Data Program funding)

Evaluation: 2.08 FTE (staff)  
0.3 FTE (guest)

Dissemination: 0.25 FTE

Management,  
Coordination: 0.3 FTE

**TOTAL: 2.93 FTE**

# FY05 Accomplishments

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## Mass Chain and Nuclide Evaluation (2.05 FTE)

- **Submitted:**

A=22, 166, 176, 181, 232, 237,  $^{225}\text{Fr}$  (68 nuclides, including 19 priority nuclides)

- **Published:**

A=21, 22, 212

- **Reviewed:** 2 mass chains (A=203, 233).

## DDEP Activity (0.13 FTE)

- **Coordinated** international collaboration.

- **Reviewed** 5 radionuclide evaluations.

## Web Page Maintenance and Software Support (0.25 FTE)

- **Maintained** approximately 12 web pages; usage continues to increase.

- **Supported** *Isotope Explorer 2* (C++, Windows) and *Isotope Explorer 3* (Java, HTML) application software.

- **Served** 207K distinct hosts who downloaded ~159 Gb data in FY05.

# Accomplishments - continued

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## Neutron Capture Data Evaluation (0.20 FTE)

A. Collaboration with Chemical Research Centre, Budapest, Hungary:

- Measured  $(n,\gamma)$  cross section for  $^{24}\text{Mg}$ .

B. Collaboration with LLNL:

### **Goal:**

To improve the quality of information in the ENDF database by adding:

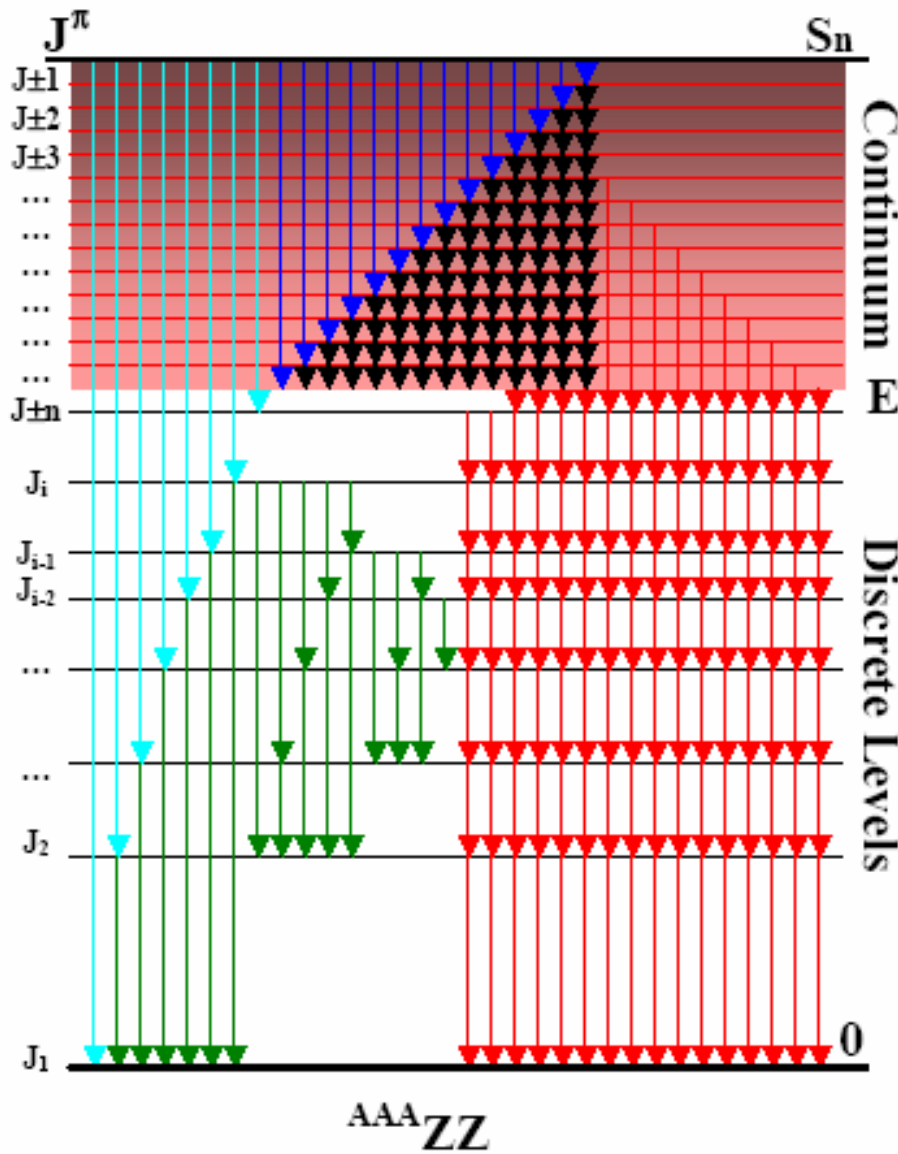
- discrete line  $(n,\gamma)$  information ( $E=\text{thermal}$ ) from recently-completed EGAF (Evaluated Gamma-ray Activation File) database, now available from IAEA (<http://www-nds.iaea.org/pgaa/>) and Isotopes Project websites, and
- photon quasi-continuum information calculated using statistical model (with parity effects on level densities included).

### **Importance:**

For use in coupled neutron-photon transport codes, including MCNP.

### **Progress:**

- Statistical analysis (DICEBOX code) of  $(n,\gamma)$  capture cross section data for Pd isotopes reported at CGS12 conference, September 2005.
- New faster software, COSMO, developed (R. Firestone) to facilitate the necessary statistical-model calculations.



## Constrained Statistical Model (COSMO) Calculations

### Simple Quasi-Statistical Model

- Primary  $\gamma$  to discrete level  
-  $I_\gamma$  from experiment
- Primary  $\gamma$  to binned continuum  
-  $I_\gamma \propto S(E)\rho(E, J_f)$
- Secondary  $\gamma$  from discrete level  
-  $I_\gamma$  from experiment
- Continuum bin to Continuum bin  
-  $I_\gamma \propto S(E)\rho(E, J_f)$
- Continuum bin to discrete level  
-  $I_\gamma \propto S(E), \rho(E, J_f)=1$

Where  $S(E)$  is the average  $\gamma$ -ray strength for E1, M1, and E2 transitions, and  $\rho(E, J_f)$  is the level density for spin  $J_f$ .

The continuum is divided into  $n$  energy bins. Discrete  $\gamma$ -rays come from EGAF file. The calculation is constrained so that

$$\sum I_\gamma(\text{primary}) = 100 = \sigma_\gamma$$

$$\sum I_\gamma(\text{GS}) = 100 = \sigma_\gamma$$

# Other Activities

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## Workshop Lectures:

- ICTP Workshop on Nuclear Data for Activation Analysis (Trieste, Mar. 2005): one lecturer (2 lectures).
- IAEA/ICTP Data Evaluation Workshops (Trieste, Apr. 2005): two lecturers (6 lectures).

## Publications/Invited Talks

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- 3 Nuclear Data Sheets publications
- 5 other data-related publications
- 8 invited talks/lectures
- 1 nuclear-data related report

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# Publications

## Mass Chain Evaluations: 3 papers

- Nuclear Data Sheets for A=21*, R. Firestone, *Nuclear Data Sheets* **103**, 269 (2004).  
*Nuclear Data Sheets for A=212*, E. Browne, *Nuclear Data Sheets* **104**, 427 (2005).  
*Nuclear Data Sheets for A=22*, R.B. Firestone, *Nuclear Data Sheets* **106**, 1 (2005).

## Other Data-Related Publications: 5 papers

- *Table of Radionuclides*, M.-M. Bé, V. Chisté, C. Dulieu, E. Browne, V. Chechev, N. Kuzmenko, R. Helmer, A. Nichols, E. Schonfeld, R. Dersch, Bureau International des Poids et Mesures Monographie BIPM-5 (2004).
- *The Evaluated Gamma-ray Activation File (EGAF)*, R.B. Firestone, AIP Conference Proceedings **769**, *International Conference on Nuclear Data for Science and Technology*, eds. R. Haight, P. Talou, T. Kawano, M.B. Chadwick, p. 225 (2005).
- *Nuclear Data for the Present Age*, Coral M. Baglin, AIP Conference Proceedings **769**, *International Conference on Nuclear Data for Science and Technology*, eds. R. Haight, P. Talou, T. Kawano, M.B. Chadwick, p. 230 (2005).
- *The Evaluation of Gamma Ray Emission Probabilities in the Decay of  $^{56}\text{Co}$* , Desmond MacMahon and Coral Baglin, AIP Conference Proceedings **769**, *International Conference on Nuclear Data for Science and Technology*, eds. R. Haight, P. Talou, T. Kawano, M.B. Chadwick, p. 370 (2005).

# Publications - continued

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- *Revisiting the U-238 Thermal Neutron Capture Cross Section and Gamma-emission Probabilities from Np-239 Decay*, A. Trkov, G.L. Molnár, Z.S. Révay, S.F. Mughabghab, R.B. Firestone, V.G. Pronyaev, A.L. Nichols, M.C. Moxon, Nucl. Sci. Eng. **150**, 336 (2005).

## Invited Talks:

## 8 Talks

- *Physics of Gamma-Ray Spectroscopy Measurements and New Data and Directions for Neutron Activation Analysis*, R.B. Firestone, two 90-minute lectures at the ICTP (Trieste) *Workshop on Nuclear Data for Science and Technology: Materials Analysis*, 7-18 March, 2005.
- *ENSDF – Reaction Data*, Coral M. Baglin, two 90-minute lectures at the IAEA/ICTP *Workshop on Nuclear Structure and Decay Data: Theory and Evaluation* held in Trieste, April 2005.
- *ENSDF – Adopted Levels and Gammas*, Coral M. Baglin, two 90-minute lectures at the IAEA/ICTP *Workshop on Nuclear Structure and Decay Data: Theory and Evaluation* held in Trieste, April 2005.
- *ENSDF - Decay Data*, Edgardo Browne, two 90-minute lectures at the IAEA/ICTP *Workshop on Nuclear Structure and Decay Data: Theory and Evaluation* held in Trieste, April 2005.



# Publications - continued

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## **Nuclear-Data Related Report:**

- *Thermal Neutron Capture Cross Sections of the Palladium Isotopes*, R.B. Firestone, M. Krticka, D.P. McNabb, B. Sleaford, U. Agvaanluvsan, T. Belgya and Z.S. Révay, *Conference on Capture Gamma-Ray Spectroscopy and Related Topics (CGS12)*, U. Notre Dame, September 4-9, 2005.